REMARKS

Reconsideration of the above-identified application respectfully requested. With the present amendment, claims 1, 17, and 32 have been amended. Claim 31 has been cancelled, that feature of the invention having been added to independent claims 1, 17, and 32. Non-elected claims 2, 4-16, 18-30, and 33-39 have been cancelled. Also, in response to the Examiner's objection, claim 1 has been amended to correct an obvious typographical error. The noted "signals(s)" has been changed to "signal(s). Claim 3, dependent on claim 1, also should be deemed proper in light of the amendment of claim 1.

Before addressing the claim rejections, a brief description of the invention may be of value. The present invention includes an apparatus and method for distributing optical signals, which may be utilized in various telecommunications applications such as switching, multiplexing, and demultiplexing. This signal distribution is simply achieved through use of a movable diffractive optical element (MDOE). A particularly advantageous MDOE embodiment consists of a rotatable plate having a plurality of facets, each facet including a diffraction grating having a particular grating spacing. The plurality of facets may be achieved by use of a holographic film with a plurality of diffraction gratings being superimposed, each diffraction grating being angularly oriented or offset with respect to each other. It should be noted that claims 1, 17, and 31 have been amended to include a holographic diffraction grating. Particularly, these claims have been amended to recite the above described feature, namely, an MDOE "having a surface carrying a holographic diffraction grating including an array of facets, each of said facets carrying a diffraction grating(s) which are superimposed, each being angularly offset with respect to each other". With such a holographic diffraction grating, at a given angle with respect to a light source, a diffraction grating of a particular spacing will be presented. By rotating the plate to a different angle with respect to the light source, a different diffraction grating with a different diffraction grating spacing will be presented. Because the diffraction gratings are superimposed holographically on a single film, a significant number of facets or diffractions gratings may be utilized on a relatively small plate.

Considering the simplest implementation of the invention, a source having a signal of a particular frequency is directed onto the MDOE. At a given position of the MDOE with respect to the source, a particular facet or diffraction grating will be presented, the input signal will be diffracted, and the resulting output signal directed to a select output station. By changing the position of the MDOE, a different facet associated with a different diffraction grating spacing will be presented and the input signal will be diffracted at different angle. At the second position of the MDOE, the resulting output signal will be directed to a another output station.

In order to move the MDOE to different positions, a stepper motor may be used with the plate described above. Alternatively, the diffraction grating of the MDOE may be attached to a

magnet. By electromagnetically coupling the magnet with a coil, when current runs through the coiled wire, a magnet field is generated which interacts with the magnet and causes it, and thus the diffraction grating, to move.

Turning now to the claim rejections, it is noted that claims 1, 3, 17, 31, and 32 have been rejected under 35 U.S.C. § 102 as being anticipated by U.S. Patent No. 6,388,789 issued to Bernstein (hereinafter, "Bernstein").

Bernstein primarily describes a two-axis magnetically actuated device that is capable of angular deflection about each axis. The device includes two nested rotational members, an inner rotational member that is attached to an outer rotational member, which in turn is attached to a base member. Two pairs of coils are located on the surface of the inner rotational member. When a current is applied to the coils, magnet moments are created. Movement of the inner and outer rotational members may be affected by applying a magnetic field when one or more of the pairs of coils are energized.

Bernstein discloses that any number of optical elements may be mounted on the disclosed two-axis mount. Among the optical elements listed are diffraction gratings. However, Bernstein discloses only that a diffraction grating may be formed on or applied to the mount. Bernstein does not cite a purpose for applying a diffraction grating or teach that more than one diffraction grating may be applied. In particular, Bernstein fails to recognize the advantages of utilizing a plurality of diffraction gratings having different grating spacings to direct optical signals. This is particularly apparent when considering Figs. 7A and 7B. In order to direct a plurality of signals from input ports to output ports, Bernstein discloses a plurality of devices such as those described above, each having a **reflective** surface. It is only the mechanical movement of the inner and outer rotational members that directs optical signals to output ports. Looking to Fig. 7A, if two signals having two different wavelengths were directed from port 201a onto switching element 202 as shown in Fig. 7A, both signals would be directed to output port 201b.

In contrast, the direction of optical signals is achieved in the present invention through diffractive means. Two different signals from a single input may be directed onto the surface of a single MDOE and may be diffracted and directed to two different outputs. Particularly with respect to the embodiment wherein the diffraction gratings are holographically superimposed, a large number of diffraction gratings may be utilized on a single surface. This eliminates the need for the plurality of mounts configured as in Fig. 7A of Bernstein, and illustrated even more graphically in Fig. 7B. Looking to Fig. 5 of the present application, a single broadband input may be directed onto the surface of a single MDOE where it is diffracted into a plurality of output signals that then may be directed to output stations (e.g., cables) located 3-dimensionally about

the MDOE. Such an apparatus and method, as recited in amended claims 1, 17, and 31, are neither disclosed nor taught in Bernstein.

Claim 3, dependent on amended claim 1, recites that the MDOE is provided as a magnet having the holographic diffraction grating attached thereto, and which is magnetically coupled to a coil energizable for movement of the magnet and the diffraction grating. Nowhere does Bernstein disclose a magnet/coil configuration wherein a diffraction grating is attached to a magnetic element which is free to move while the coil element remains fixed. Rather, in Bernstein, optical elements are disclosed only as being positioned on movable surface 3A (Fig. 1A), to which energizable coils, as at 6 and 7 (Fig. 1A), also are attached.

It is noted that claims 1, 3, 17, 31, and 32 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 4,337,993 issued to Kompfner (hereinafter, "Kompfner") in light of U.S. Patent No. 5,613,022 issued to Odhner, *et al.* (hereinafter, "Odhner").

The Examiner cites Kompfner as disclosing a movable diffractive optical element used to direct optical signals. Applicants respectfully disagree. Kompfner does disclose a system for directing optical signals that utilizes a holographic element. However, for both disclosed forms of the optical signal, the diffractive element is fixed. See col. 1, lines 39-45 ("In a first form the optical system may comprise two arrays of optical devices and one phase grating plate all fixed relative to each other...)and col. 1, lines 46-54 ("In a second form the optical system may comprise two arrays of optical devices and two phase grating plates respectively fixed relative to the two arrays...). The holographic element (phase grating plate 11a) is moved while it is being developed as described in connection with Fig. 2. However, once the plate has been developed, its location within the system is fixed. "The plate 11a shown in Fig. 1(b) is therefore specific to the ends of the two bundles of fibres used to produce it, and is capable of coupling only those two bundle ends in those relative positions and orientations, and only when the plate itself is in one particular position and orientation relative to the bundle ends." Col. 4, lines 15-20. Thus, as created, the holographic element directs a particular input signal to a particular output. To direct an input signal to a different output signal, a reflector (at 37 in Fig. 3(b)) is provided. See Col. 5, lines 34-37. As with the Bernstein reference, Kompfner does not disclose or teach a holographic element having a plurality of superimposed diffraction gratings of different grating spacings and the movement of that holographic element to generate output signals that may be direct among a plurality of output stations.

With respect to the Odhner patent, Applicants first respectfully submit that the patent is non-analogous art. Applicants consider that the recognition that the technology for constructing a display could be adapted to create a telecommunications device to be one of the inventive contributions contained in the telecommunications application.

The success of Applicants' device in a telecommunications application is unexpected

given the different goals and parameters of color display creation and telecommunications switching. In a color display application, the goal is to present graphics, alphanumeric characters, and the like to an observer. As such, a display device or system generally must be designed to utilize a broad band visible light source so that the resulting display created may be perceived by an observer. It also is important that color changes occur slowly enough that the observer can perceive the changes. Such a device should maintain a smooth transition between pixels for the eye. The display would look "choppy" otherwise. Display switching parameters, thus, are dictated by the limitations of the observer rather than by limitations of the hardware.

By contrast, in a telecommunications application, the goal is to transmit as much data or information as possible, as accurately as possible, using optical fibers or cables. As a result, telecommunications applications will utilize higher frequency signals, for example, in the 1.3 to 1.65 micron range. Another concern in telecommunications applications is attenuation losses due to the use of fiber optic cables. Attenuation losses may be decreased by using the above-noted higher frequency signals. These hardware concerns typically are not encountered in display applications. Another notable difference between telecommunications and display applications is switching times. In order to ensure the accuracy of transmitted data, telecommunications switches generally include buffers to store information. That way, data can be maintained in storage during the transition times and then sent out after the switch has been made. Longer switching times simply require larger buffers.

Because of the above-noted differences, one of ordinary skill in the art addressing the problem of creating a telecommunications switching device would not look to the display field to solve the problem.

Even if the Odhner patent is properly cited, that patent does not make up for the deficiencies of Kompfner. Odhner discloses a unique method for creating graphics displays. Using this technique, a diffraction grating, carried by an electroactive or magnetoactive film, is connected to an energy source that is energizable for movement of the film. The diffraction grating will diffract a particular color when illuminated by a broad band source at a particular angle. Movement of the film carrying the diffraction pattern will change the angle of incident light to the diffraction grating. This will cause the beam diffracted at a given angle to change its wavelength. For a broad band visible light source (although the present invention is equally applicable to ultraviolet (or UV) and infrared wavelengths of energy), it is possible to cause a pixel to reflect the colors, *inter alia*, red, green, and blue, as a function of the rotation of the diffraction grating.

Unlike the present invention, the device of Odhner utilizes movement of a diffraction grating to convey signals of different wavelengths or colors sequentially to a single position, namely, to an observer. The present invention utilizes a holographic diffraction grating having a

plurality of diffraction grating spacings superimposed thereon. By moving the diffractive optical element, input signals directed onto the MDOE may be diffracted to different output stations. The output stations to which the input signals will be directed will be determined by the position of the MDOE with respect to the light source. Such direction of signals to different locations by a holographic diffraction grating, which is not disclosed by Kompfner, also is neither taught nor disclosed in the Odhner patent.

Finally, with particular reference to claim 3, Odhner discloses embodiments that employ magnets and energizable coils to provide deflection of a diffraction grating according to the principles of electromagnetics. Each of the specifically described variations of the magnetic approach in the Odhner patent includes fixed permanent magnets and a rotatable coil to which a diffraction grating is affixed. Interaction of the permanent magnets' fields and the magnetic field generated by the coil provide the force that causes the coil, and thus the diffraction grating, to rotate.

In testing an embodiment using a fixed coil and a moving magnetic component to which a diffraction grating is attached, it was expected that providing a fixed coil and moving magnet, instead of a fixed magnet and moving coil, would result in equivalent performance. However, using the moving magnet approach unexpected and beneficial results were realized including smaller mass relative to torque produced and less power dissipation, less hinge material variance in spring constant and conductivity, fewer production quality control issues, and lower production process costs. In addition to the deficiencies noted above, Odhner does not disclose or suggest the use of a diffraction grating affixed to a moving magnet.

One of the inventors of the present invention, Jefferson E. Odhner, recently discovered the attached publication, which is an article entitled "Micromotor grating optical switch" (hereinafter, "micromotor article"). It is applicants' belief that the micromotor article does not affect the patentablity of the claims as amended. However, to comply with their duty under Rule 56, applicants are submitting the article for the Examiner's consideration.

The micromotor article discloses a salient-pole motor switchable to three different positions (Fig. 1). The center part of the rotor is divided into 4 pie-shaped segments. Each segment has a diffraction grating etched into it. The grating spacings or periods of the segments alternate between 2 and 4μm, oppositely disposed segments having the same grating spacing (i.e., either 2μm or 4μm). See, Page 1734, Col. 1, paragraph 2. Light incident on the center part of the rotor is diffracted to yield two perpendicular rows of diffractive orders. It is stated in the article that the result is a spatial light switch with multiple outputs for a single input.

Applicants respectfully submit that this article, either alone or in combination with the other cited references, does not disclose or teach the invention as recited in the amended claims. In particular, the micromotor article does not disclose the use of a single holographic film

having a plurality of diffraction gratings superimposed thereon. The micromotor article discloses only etched or ruled diffraction gratings on a polysilicon surface. Using that method, the number of diffraction gratings that could be applied to the rotor center would be limited by the size of the rotor. The present invention is not so limited because the MDOE incorporates a holographic diffraction grating. With the diffraction gratings superimposed holographically on a single film, a significant number of facets or diffractions gratings may be utilized on a relatively small plate. As described above, at a given angle with respect to a light source, a diffraction grating of a particular spacing will be presented. By rotating the plate to a different angle with respect to the light source, a different diffraction grating with a different diffraction grating will be presented.

As the micromotor article recognizes, the ability to quickly move from one position to another (i.e., as evidence by rise times and settling times) is essential to a switching device. The greater the size, and hence the mass, of a device, the greater will be the time needed to switch from one position to another. With the present invention, a great number of diffraction gratings may be employed without an increase in the mass or weight of the device. Also, the use of a greater number of diffraction gratings means that more output signals can be generated and directed to a greater number of output stations.

In view of the amendments and remarks submitted herewith, allowance of the claims and passage to issue of this application respectfully requested.

Respectfully submitted,

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Diane E. Burke

Diane E. Burke
Reg. No. 45,725
Mueller and Smith, L.P.A.
Mueller-Smith Building
7700 Rivers Edge Drive
Columbus, Ohio 43235-1355
Tel.: 614-436-0600
Fax: 614-436-0057
email: dburke@muellersmith.com

MARKED-UP SET OF AMENDED CLAIMS
SERIAL NO. 09/836,685

1. Method for treating optical signals from a source thereof, which comprises the steps of:
   (a) providing a movable diffractive optical element (MDOE) having a surface carrying a holographic diffraction grating including an array of facets, each of said facets carrying a diffraction grating(s) which are superimposed, each being angularly offset with respect to each other;
   (~~a~~ b) directing a source of input optical signal(s), each of said input signal(s) being associated with a given wavelength, onto ~~a~~ said ~~movable diffractive optical element~~ (MDOE~~) to generate output signals(s)~~, ~~each of said input signal(s) being associated with a given wavelength~~ to generate output signal(s);
   (~~b~~ c) supplying one or more output station(s); and
   (~~c~~ d) moving said MDOE to distribute said output optical signal(s) among said output station(s).

3. The method of claim 1, wherein said MDOE is provided as a magnet having ~~a~~ said holographic diffraction grating attached thereto, and being magnetically coupled to a coil energizable for movement of said magnet and said diffraction grating.

17. A system for treating optical signals from a source thereof, which comprises:
   (a) a source carrying input optical signal(s), each of said signal(s) being associated with a particular wavelength;
   (b) a movable diffractive optical element (MDOE) having a surface carrying a holographic diffraction grating including an array of facets, each of said facets carrying a diffraction grating(s) which are superimposed, each being angularly offset with respect to each other, said MDOE being positioned to intercept said input optical signal(s) for generating and distributing output optical signal(s) and;
   (c) output station(s) positioned to receive said output optical signal(s) from said MDOE.

32. In a method for treating optical signals wherein optical signals provided by fiber optic cable(s) or laser diode(s) as input optical signals are distributed among output stations as output optical signals, each of said output stations comprising optical connector(s) positioned to receive said output optical signals, said optical connectors being selectively combinable to permit any combination of said output optical signals, the improvement which comprises the steps of:

(a) providing a movable diffractive optical element (MDOE) having a surface carrying a holographic diffraction grating including an array of facets, each of said facets carrying a diffraction grating(s) which are superimposed, each being angularly offset with respect to each other;

(~~a~~ b) directing said source of input optical signals onto ~~a~~ said ~~movable diffractive optical element (~~MDOE~~)~~ to generate output signals, each of said input signals being associated with a given wavelength; and

(~~b~~ c) moving said MDOE to distribute said output optical signals among said output stations.

MARKED-UP AMENDED SPECIFICATION PARAGRAPHS
SERIAL NO. 09/836,685

The paragraph located at page 1, lines 2-4:

~~This application is cross-referenced to commonly assigned Application Serial No. 09/663,850, filed on September 18, 2000 (Attorney Docket No. LUC 2-027-3), the disclosure of which is herein incorporated by reference.~~ This application is a continuation-in-part of application serial number 09/372,316, filed August 11, 1999; and is cross-referenced to commonly-assigned application serial number 09/663,850, filed on September 18, 2000 (Attorney Docket No. LUC 2-027-3), the disclosure of which is herein incorporated by reference.

The paragraph located at page 2, lines 12-18:

A number of technological advances have made DWDM possible. Once such advance was the discovery that by using fused biconical tapered couplers, more than one signal can be sent on the same fiber. The result of this discovery was an increase in the bandwidth for one fiber. Another important advance was the use of optical amplifiers. By doping a small strand of fiber with a rare earth element, usually erbium, an optical signal can be amplified without converting it back to an electrical signal. Optical amplifiers now are available which provide more efficient and precise flat gain with significant total power output of about 20 dBm.

The paragraph located at page 2, line 31 - page 3, line 5:

Given the greater number of channels, and corresponding signals, which can be carried on a single optical fiber, multiplexing and demultiplexing has become increasingly important. Current methods for multiplexing and demultiplexing include the use of thin film substrates or fiber Bragg gratings. For the first method, a thin film substrate is coated with a layer of dielectric material. Only signals of a given wavelength will pass through the resulting substrate. All other signals will be reflected. See, for example, U.S. Patent No. 5,457,573. With fiber Bragg gratings, the fiber optic cable is modified so that one wavelength is reflected back while all the others pass through. Bragg gratings are particularly used in add/drop multiplexers. With these types of systems, however, as the number of transmitted signals increases, so does the number of required films or gratings for multiplexing and demulitplexing. See U.S. Patent No. 5,748,350 and U.S. Patent No. 4,923,271. Therefore, more efficient, less ~~expense~~ expensive methods for multiplexing and demultiplexing transmitted signals continue to be sought.

The paragraph located at page 4, lines 22-34:

Referring to the drawings, Fig. 1 is a schematic representation of an RDOE switching input optical signals emitted by a laser diode assembly onto ~~lens~~ lenses that are associated with optical fibers. A source is provided, as represented by numeral 10, which source is composed of one or more input optical signals, each of which is associated with a particular wavelength (λ) or energy. In accordance with the convention in the field, the term "wavelength" is used in this Application to mean one or more wavelengths or a band of wavelengths. Also throughout this application, an "s" in parenthesis following a given element is used to indicate the presence of at least one or more of that element. For example, the term "optical signal(s)" means one or more optical signals. Source 10 in Fig. 1 is provided by a laser diode assembly, however, any other device or combination of devices capable of supplying modulated optical signal(s) may be used. Such a device or devices, for example, may include optical cable or fiber. Source 10 is directed toward the surface of rotatable diffractive optical element (RDOE) 12. RDOE 12 diffracts the input optical signal(s) of source 10 at different angles according to the diffractive equation:

The paragraph located at page 5, lines 11-25:

Three output stations are provided, as at 14, 16 and 18, for receiving the diffracted output optical signals, $\lambda 1$ and $\lambda 2$, as shown at 20 and 22, respectively. With RDOE 12 at a first position as depicted in Fig. 1~~.~~, output stations 14 and 16 receive output optical signals 20 and 22. Fig. 2 depicts RDOE 12 rotated to a second position, the rotation direction being in the plane parallel to RDOE 12. In this second position, the angle at which the optical signals are diffracted has changed and output optical signals now are directed at output stations 16 and 18. Thus, by rotating RDOE 12, optical signal(s) may be switched among a number of output station(s). Output stations 14, 16, and 18 shown in Figs. 1 and 2 are optical fibers, but the output station(s) may be any mechanism capable of detecting or transmitting an optical signal. A system for switching a source among three output stations illustrates a simple use of the method of the invention. As will be illustrated later, the simplicity of the method facilitates distribution of source of optical signals among a multitude of output stations. A lens assembly for focusing the optical signal(s) is provided in conventional fashion, for example, as shown at 24, 26, and 28 in Figs. 1 and 2. Structure necessary to implement such a lens assembly is not described herein as it is well-known to those skilled in the art.

Table 1 located at page 7, lines 1-4:

TABLE I

	Position 1	Position 2	Position 3
Output Station 1	--	~~W1~~ $\underline{\lambda 1}$	~~W2~~ $\underline{\lambda 2}$
Output Station 2	~~W1~~ $\underline{\lambda 1}$	~~W2~~ $\underline{\lambda 2}$	~~W3~~ $\underline{\lambda 3}$
Output Station 3	~~W2~~ $\underline{\lambda 2}$	~~W3~~ $\underline{\lambda 3}$	~~W4~~ $\underline{\lambda 4}$
Output Station 4	~~W3~~ $\underline{\lambda 3}$	~~W4~~ $\underline{\lambda 4}$	--

The paragraph located at page 8, lines 26-36:

Looking to Fig. 6, a top view of the optical connectors illustrated in Fig. 5 is shown. The components of Fig. 6 retain the numeration of Fig. 5. RDOE 12 is rotatable to eight positions, shown at 154, 156, 158, 160, 162, 164, 166, and 168. In each position, wavelengths will be diffracted to optical connectors located along equal lines of longitude~~.~~ (sphere 116, Fig. 5). Note that the RDOE 12 axis of rotation is perpendicular to the grating plane. When RDOE 12 is positioned at position 154, no output optical signals are conveyed to any optical connectors. At position 156, output optical signal λ3 will be received at output station 114. Output stations 110 and 112 will not receive signals. With RDOE 12 in a third position, as shown at 158, output optical signal λ1 will be received at output station 110 by optical connector 134. No output optical signal will be received at output stations 112 and 114. This grating will continue for all 8 positions.

The paragraph located at page 10, line 16 - page 11, line 6:

The present invention, then, includes directing of output optical signal(s) to one or more output stations by varying the effective spacing of a diffractive optical element through rotation. One embodiment for RDOE 12 involves the use of a diffraction grating on a thin film that is connected to an energy source, energizable for movement of the film. Such movement changes the effective spacing of the diffraction grating on the film. A diffractive grating or hologram may be embossed on the thin film to form the diffractive grating. The film may be ~~PVDF~~ <u>polyvinylidene fluoride (PVDF)</u> or any other piezoelectric film that deforms by a small amount when subjected to an electric field. The diffractive grating or hologram embossed on the thin film is rotated about a pivot point located at any position along the thin film. This pivot point may be, for example, at either end or at the center of gravity. The energy source, energizable to move the thin film, may

be provided in any number of electromagnetic configurations. One such configuration includes the combination of an energizable coil, or multiple coils, with the thin film, the combination being pivoted at the center. Magnets are located either below or to the sides of the film such that when the coils are energized, a magnetic flux is created and the film with its diffractive grating rotates about the pivot axis. Such structures are described in further detail in U.S. Patent No. 5,613,022, entitled "Diffractive Display and Method Utilizing Reflective or Transmissive Light Yielding Single Pixel Full Color Capability," issued March 18, 1997, which hereby is expressly incorporated herein by reference.

The paragraph located at page 12, lines 1-9:

Turning now to Fig. 7B, a side view of the RDOE of Fig. 7A is shown revealing the connection of the above-described elements to a printed circuit board. Numeration from ~~Fig. 1~~ Fig. 7A is retained. Printed circuit board (PCB) 202 is seen to have ground plane 204 and + voltage bus 206. FET 190 is connected in series with conductor 188, ground connector 208 and + voltage connector 210 (~~Fig. 1~~ Fig. 7A) being connected to ground plane 204 and + voltage bus 206, respectively. Similarly, the capacitance sensor located on stop 194 is connected to ground plane 204 at ~~211~~ 216 and + voltage bus 206 at 212. The connection of elements to PCB 280 is intended to be illustrative and not limiting of the present invention, as it will be obvious to those skilled in the art that other arrangements may be provided.

The paragraph located at page 12, lines 10-23:

In addition to RDOEs involving manipulated films or pivoted magnets or coils, the present invention may be implemented using one of a number of planar rotational embodiments of RDOE 12. For each of these embodiments, an array of facets may be achieved on the RDOE by providing a single diffraction grating of constant spacing or an array of diffraction gratings, each of which may have a different spacing wherein each diffraction grating element of the array may be disposed in juxtaposition or may be spaced apart, or by using a holographic diffraction grating array wherein the array of facets are superimposed. With a single diffraction grating, a facet is associated with each rotational position of the ~~FRE~~ faceted rotatable element (FRE), thus creating an array of facets to an observer. Where each facet of the array is a separate diffraction grating, the facets may be non-uniformly or uniformly placed along or across RDOE 12, however, the location of each facet within the array is known, for example, each location can be stored in the memory of a microprocessor. With the location of each facet in the array ~~know~~ known, the RDOE may be rotated such that input signal(s) illuminate select facet(s). Thus, desired output signal(s) are generated and directed to appropriate output station(s).